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XXXV. *A Description of the Exocoetus Volitans, or Flying Fish.* By Thomas Brown, Surgeon, near Glasgow.
Communicated by Dr. Fothergill, F. R. S.

Read June 4, 1778. **T**HE best representation I can give of the flying fish is in the accompanying sketch, drawn from one of the middling size, about nine inches long, and full four round at the thickest part^(a).

From the largeness of the head, and the body being neither prominent above or on the sides, the eyes are situated in such manner as to discover their danger or prey almost all around them; but when they are pushed out of their sockets, which the fish is capable of doing considerably, their sphere of vision is greatly increased.

The skin is uncommonly firm for the size of the animal, and their scales large and thick. As they have no membrane to shade the eye, they are not able to cover the pupil in any of its motions.

The wing is no other than a large pectoral fin, composed of seven or eight ribs or pinions, the largest of which being uppermost, reaches almost to the tail, the

(a) The naked out-line shows the form of the mouth when opened.

Mr. BROWN'S Account of

rest gradually shortening to the bottom, are connected by thin membranous pellucid films or webs from their roots which spring near the gills to the very summit, where they lose themselves in slender points: at their thickest ends approaching each other, they unite in a line, which, in correspondence with the form of the gills, is nearly the segment of a circle; though there they are connected, it is in such a manner as to allow of being drawn a little asunder, which separation is considerable at the other extremity. The united ends are grooved or hollowed, to receive a ridge or protuberance of the scapula, to be afterwards mentioned, forming a joint capable of little motion, excepting backward and forward; in the one case, the wing lies close to the side; in the other, it is moved from the side forward, forming an acute or rectangle with the body of the fish; but neither at this time expanded. These two motions are performed, I presume, in common swimming.

The fore-part of its body, from near the back bone downward to the bottom, where it terminates in a point, is fortified just behind the gills by a flat bone on each side, which answer all the purposes both of clavicles and scapulæ in land animals: they are firmly united before, or at the inferior part where they are narrower, and running upward, widening as they approach the back, they
become

become somewhat hollow towards the body, and a little convex outwardly at the broadest part; but towards the gills the edge of the bone on each side is turned outward, like the cape of a garment, to form a smooth surface for them, and at the same time to give lodgement to a strong muscle under it, which fills the whole space, on the superior part of the bone; for on the posterior part of it the articulation is made with the wing.

Just above the joint the scapula is smooth and hollowed, in the manner of a crescent, to allow a tendon to pass from a small muscle which lies on the inferior part of it, next to the body of the fish.

The upper part of the ridge that forms the joint, and is received by, or articulated with the wing, is rounded and somewhat enlarged, over which the strong tendon, bound down by a ligament, together with some fibres of the muscle lodged under the inverted edge of the bone, is obliged to pass, and, going over the joint, is inserted into the root of the strongest and uppermost pinnion; near to which place, the tendon, passing in the semi-lunated part of the scapula before mentioned as over a pulley, is also inserted a little way beyond the joint.

By the action of these two muscles, pulling in opposite directions, though both upwardly, at the same time

that the lower pinions are kept down by the muscles on the anterior, by those on the posterior and inferior part of the scapula; I say, the effect of the action of these two muscles is, to pull the pinions upward, and at a greater distance from one another, or in other words to expand the wing; for the joint does not allow of any motion upward, and if it did, it would not in the least influence the size of it.

The other muscles that lie on the external, internal, and inferior parts of the scapula, together with several small ones that run backward: these, I say, also serve to move the wing backward and forward. This scapula and wing, with all its apparatus of muscles, can be easily divided, except at the superior part, from the muscles that form the fore part of the body of the fish, being only connected by a cellular medium.

The globe of the eye is large in proportion to the animal; the pupil large too, and nearly, if not altogether, circular. The cornea is less transparent than in the generality of fishes; the fore part of the globe is a good deal flattened, as if a segment or portion had been cut off, for so small a part of the aqueous humour is contained between the cornea and iris, which is of a silver colour, that they are nearly in contact.

The optic nerve, though at its egress from the skull it is united by a common external membrane with that of the other eye, does not seem blended with it; this nerve, which is very large, pierces the external coat on the bottom of the ball, but not in the center; it enters on the side of the axis next the fish's body. The external tunic into which the muscles are immediately inserted, and which gives strength and figure to the whole, is very firm, tough, and almost horny: when the eye is boiled, it seems to have a continuation of fibres, and indeed is of the same colour with the septum of the eye or iris, the cornea separating readily from it, and having then the appearance of the small segment of a great circle or globe, applied to the great segment or side of a much smaller one. All the bottom of the ball is covered with this strong membrane, except in the posterior part, where it becomes abruptly much thinner, more pliant, and of a shape nearly resembling the space left by the union of four circles, or a kind of square with its sides bent inward; in the center of this the optic nerve enters, close to the side of which an opening, like a pin-hole, appears, through which I imagine a small artery passes.

The crystalline humour, both in the recent and boiled subject, is entirely spherical; in one it had the appearance of bottle glass; in the other it was bright as crystal.

When boiled it seemed to be attached to the vitreous humour, which was not then coagulated, it had an oblong blackish substance fixed to it like the fragment of a blood vessel, which I could with difficulty separate.

In the fresh fish, the bottom of the eye, except where the optic nerve entered like a small elevated white speck, was laid over with a downy pearl-coloured paint; a part of which, upon squeezing out the vitreous humour, sometimes floats on its surface. Upon removing this, a black soft painting appeared, which in the bottom of the globe, and someway round the entrance of the nerve, had a reddish cast, or streaks of red, buried in it: these were masses of fine blood vessels, which I imagine had sprung from the small perforation before mentioned. In the boiled eye, these paints were not much altered, except the red part, which, like all coagulated blood, was now become dusky. On the back part of the iris, or rather the posterior part of the aqueous humour, it was only covered over with the black coloured pigment.

The muscles of the eyes were remarkably strong, broad, and distinct; for in small fishes they are in general so pappy and tender, that it is very difficult to examine them with accuracy.

Their throat or swallow is formed of an oblong, rounded protuberance on the backpart of the fauces,

and a receiving hollowed substance on the fore part, both plentifully armed with small tenter hooks, pointing backward. They seem to have no remarkable dilatation in the canal of the bowels, in the manner of a stomach; but one tube passes directly from the mouth to the anus, on the upper or anterior part of which lies the heart; on the lower or posterior the liver and gall-bladder; and on the sides of this last are situated the rows, which consist of two lobes. On each side, and at some little distance from the heart, is a pale ash-coloured substance, somewhat resembling the lungs of small birds, which seem to join at the back, and to run united all along the hollow depression there as far as the anus. These parts were so very tender, and so little fit for examination with the hands or knife, that it was impossible for me to discover their use, or to trace any communication they might have with the throat.

Nostrils they have, and I could pass a hog's bristle through them, by the palate, into the mouth.

In the recent ones the abdomen was near two-thirds full of air. At the basis of the skull I found two little flat snow-coloured bones, irregular and rough, such as we find in cod and many other sea fishes.

Upon examining the wings after being some time exposed to the air, I find they become so dry, and the fine
thin

thin intervening membrane so rigid, that it is difficult to expand them without violence, at the same time that the motion of the whole wing backward and forward is nothing impaired; this circumstance, which only happens after the fish has been a considerable time out of the water, may have given rise to the common tradition amongst sea-faring people, that it can fly no longer than its wings are wet, and that in its flight it skims along the surface and dips, skims and dips again, with no other purpose than to moisten and keep them in a flying trim.

That in the course of one flight, at least once, twice, or perhaps thrice, it lightly touches the water is certain; but the whole is performed in so small a space of time, and its continuance in the air is of so short duration, that even in the dryest, warmest weather little is to be apprehended from the too great rigidity of the wings. In my opinion, though this circumstance of moistening them may be of some use, and a secondary advantage, yet they seem to touch the water for a more important purpose, for the same reason that a diver or swimmer, when below the surface of another element, is very frequently obliged to emerge into his own. It may also be of some use in giving the animal new force and vigour for another departure.

But as flying is only a sudden expedient, in order to escape the jaws of their enemies, and by no means their
natural

natural or usual mode of existence, there seems not to be any particular or remarkable apparatus necessary for a long subsistence, nothing is wanted but the power of motion in our atmosphere, and the drying of their wings, appears to be the only inconvenience they are likely to suffer. Hence it is, that in every other part of their frame and structure, small provision is made by all-bountiful nature for this transmigration.

In flying not only their fins and wings are much expanded, but also their tail; they skim along the surface of the deep with great velocity, somewhat in the manner of a swallow, but in straight lines, and from the blackness of their backs, the whiteness of their bellies, and forked expanded tails, they have much the same appearance^(b).

They can fly fifty, sixty, or more yards at one stretch, and repeat it a second or even a third time, only the slightest momentary touch of the surface that can be conceived intervening.

They are seldom solitary, but rise in flocks or shoals^(c). In taste they somewhat resemble a mackerel.

(b) Since writing the above, I find the ancients were acquainted with this species; PLINY mentions it under the name of the *Hirundo*.

(c) We found them in greatest quantities between the latitude of 15° and 10° N. from 20° to 30° W. of the meridian of London; but they abound between the Tropics in many other places of the vast Atlantic, as well as in the Indian Ocean.

They are drove out of their own element by the shark^(d), the porpoise^(e), the albicore^(f), the bineto^(g), and dolphin^(h), to become a prey in ours to the booby⁽ⁱ⁾, the man of war^(k), and tropic bird^(l); but I suspect their vision in air is not very distinct, as they often in their flight fall a ship-board, or strike against whatever happens to be in their way, as was the case with all these I examined: and indeed the form of the crystalline humour of the eye seems to countenance this opinion, being of the same spherical figure with that of the greatest part of those fishes that altogether inhabit the watery element.

(d) *Squalus Conductor.*

(e) *Delphinus Phocæna.*

(f) *Scomber Thynnus.*

(g) *Scomber Pelamis.*

(h) *Delphinus Coryphæna.*

(i) *Pelicanus Piscator.*

(k) *Pelicanus Aquilus, or Man of war bird.*

(l) *Phaeton æthereus.*

